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Forest
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Laboratory

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December 1980

Dividends From Wood Research

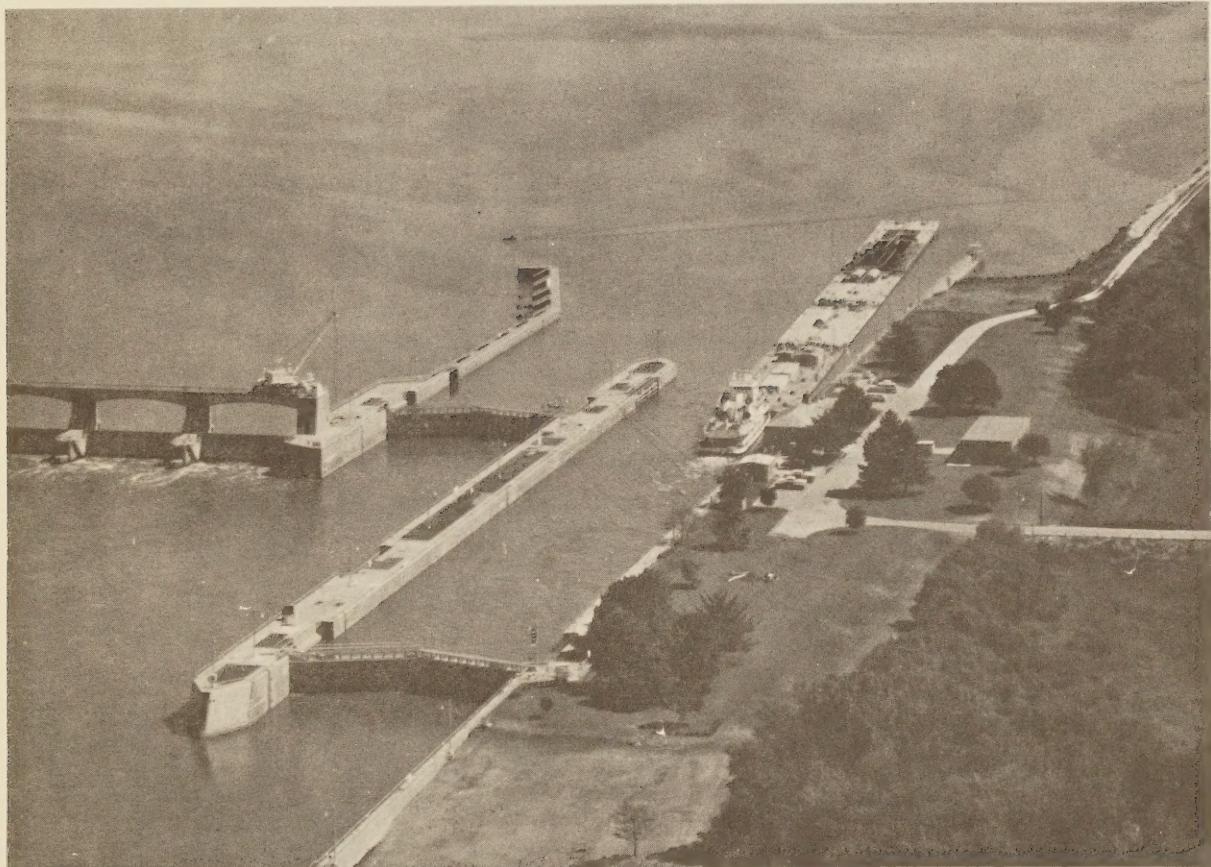
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Recent Publications



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Dividends From Wood Research

"Dividends From Wood Research" is a semiannual listing of recent publications resulting from wood utilization research at the Forest Products Laboratory. These publications are made available to the public to encourage private and commercial application of Forest Service research. The Forest Products Laboratory is maintained in Madison, Wisconsin, by the Forest Service, U.S. Department of Agriculture, in cooperation with the University of Wisconsin.

Research Highlights

Prospects for U.S. Trade in Timber Products

Darr, David R. and Gary Lindell

Forest Products Journal 30(3,4,5,6) 1980

Every person has a different set of reasons for being concerned about trade. Trade has the potential to affect everyone living in the United States. Typically, the effects of trade are viewed from the perspectives of consumers and producers, and these two groups disagree on how trade affects prices. Imports can help lower prices at the expense of domestic producers. Exports, on the other hand, can help raise prices, but at the expense of domestic consumers.

During the past two decades, the United States has been a net importer of timber products measured in both volume and value terms. Trade prospects and their implications for U.S. timber products to the year 2030 are examined in a series of four separate papers. The series organizes a framework for U.S. trade concerns along the lines suggested by the titles:

- 1 Setting, FPJ 30(3):17-21
- 2 Imports, FPJ 30(4):16-20
- 3 Exports, FPJ 30(5):21-27
- 4 Implications, FPJ 30(6):16-20

5 **Survey of Existing Performance Requirements in Codes and Standards for Light-Frame Construction**

Sherwood, G. E.

USDA For. Serv. Gen. Tech. Rep. FPL 26, 1980

Present building codes are a combination of specifications and performance criteria. A specification code or standard lists material type, quality, size, and spacing to perform a certain function. In comparison, a performance code or standard explains how a building element must perform under various mechanical or climatic load conditions.

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Performance requirements exist for most structural and environmental aspects of light-frame construction, but differ widely among the various codes and standards. In some instances, certain essential items are overlooked, such as vibration of floors, overall structure rigidity, shape and orientation for energy conservation, and condensation control. Here the author summarizes the performance requirements in existing codes and standards as background information.

6 Forest Resources for Producing Energy

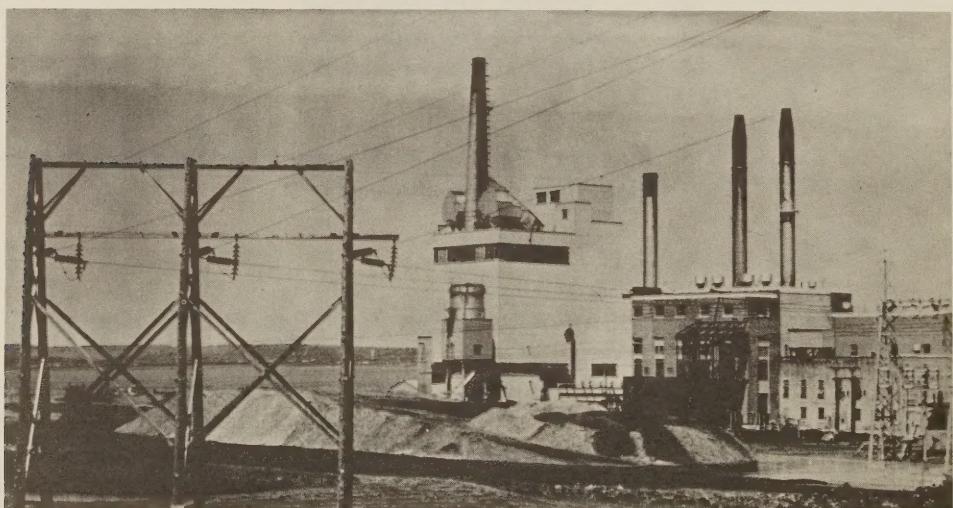
Zerbe, John I. and Andrew Baker

From: "Bioresources for Development: The Renewable Way of Life," Pergamon Press, 1980

As the costs for fossil fuels continue to rise, the prospects for using more forest wastes for energy production are becoming noticeably better in the United States. More and more woodburning boiler installations are being placed in forest products manufacturing plants, and other industries and institutions are planning to burn wood fuel.

In addition to burning wood directly for energy, it can also be converted to gas or liquid fuels. While progress is being made in developing processes for such conversion fuels, none has reached the level to permit economic operation of a plant.

Residues are the most promising near-term source of wood fuels, although other sources, particularly fuel plantations and forests managed for multiple products including fuel, could be more important in the long term. This paper reviews the prospects of wood residues as an energy source.



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7 Adhesives in Building Construction—Past, Present, and Future

River, Bryan H. and Robert H. Gillespie

Published in: Today's Problems—Tomorrow's Opportunities, The Adhesive and Sealant Council, pp. 31-42, 1980

In this country, the use of adhesives in building construction can be traced as far back as the early pioneers who filled the gaps between the logs with caulking compounds. The early use of adhesives in construction was confined to caulking or other non-structural applications. Structural use of adhesives gained real impetus with the introduction of synthetic thermosetting resin adhesives based on phenol, urea, melamine, resorcinol, and other chemicals. In the last 50 years, the use of adhesives in structural applications expanded to include plywood, glued laminated beams and arches, stressed skin and sandwich panels, hardboards and flakeboards.

Continued growth in the use of construction adhesives is predicted for the future. Much of the growth is expected in plant operations of manufactured building components. The authors discuss building adhesives through the years and on into the future.



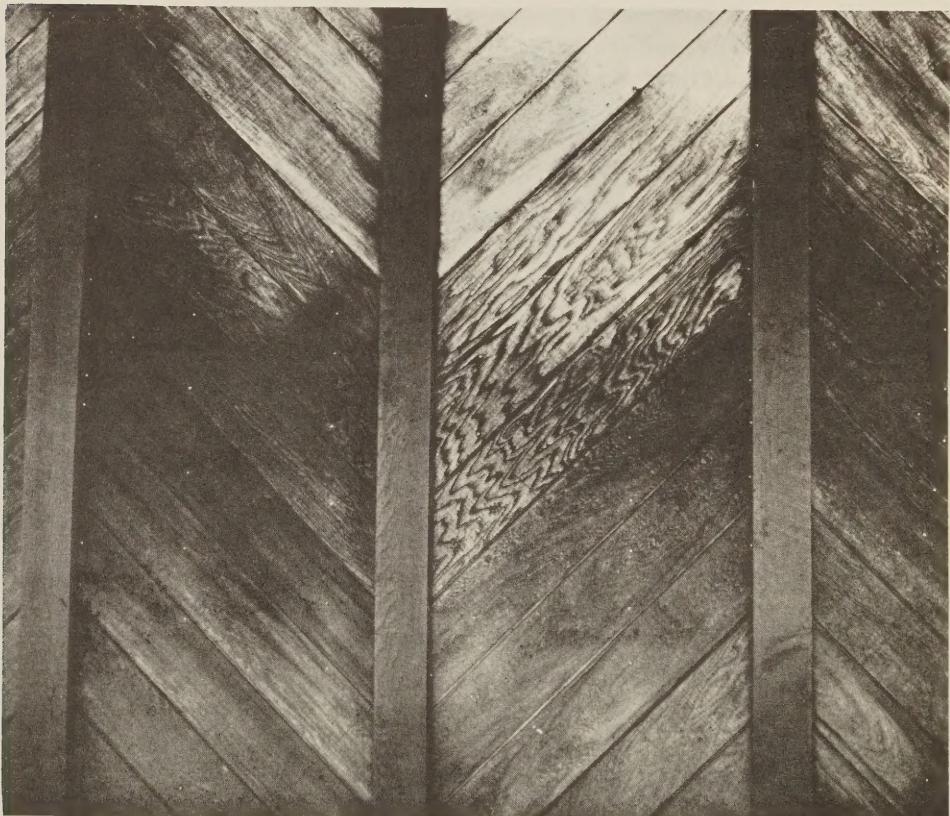
8 Performance of Mildewcides In a Semitransparent Stain Wood Finish

Feist, William C. and Edward A. Mraz

Forest Products Journal 30(5):43-46, 1980

In recent years, semitransparent stain finishes for use on exterior wood siding have gained in popularity. These finishes provide a good degree of protection against outdoor weathering while presenting a pleasing appearance. To control mildew growth, which generally causes an unsightly appearance, many semitransparent stains incorporate a mildewcide or preservative. A commonly used and highly effective mildewcide used in these stains is pentachlorophenol (penta).

Because of a number of concerns about penta and its continued use in some applications, scientists conducting research on wood finishes investigated the effectiveness of some alternative chemicals. This paper reports the results of the evaluation of six commercially available mildewcides that can be used in semitransparent stain finishes.



Dividends from Wood Research

Anatomy and Properties



Wood Anatomy of the Neotropical Sapotaceae

Kukachka, B. F.

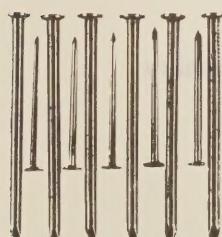
USDA For. Serv. Res. Pap. FPL 358 to 363, 1980

The tree family known as Sapotaceae represents a large volume of standing timber in the New World, especially in such areas as the Amazon Basin. However, the homogeneous nature of this family's floral characteristics makes generic identification extremely difficult. Better information would help in utilizing the timber of the Sapotaceae, especially if clearer species identification results.

On the basis of their anatomy, Dr. Kukachka suggested numerous divisions. The first seven were published in 1978 and the next six in 1979. The six below represent the next grouping. Each species is discussed in a separate research paper under the main heading of "Wood Anatomy of the Neotropical Sapotaceae" and a specific numbered subhead:

9	XIV. Elaeoluma (FPL 358)
10	XV. Sandwithiodoxa (FPL 359)
11	XVI. Paralabatia (FPL 360)
12	XVII. Gambeya (FPL 361)
13	XVIII. Gomphiluma (FPL 362)
14	XIX. Chromolucuma (FPL 363)

Buildings and Construction



15 Fire Development and Wall Endurance in Sandwich and Wood-Frame Structures

Holmes, Carlton A., Herbert W. Eickner, John J. Brenden, Curtis C. Peters, and Robert H. White

USDA For. Serv. Res. Pap. FPL 364, 1980

Fire safety is a key performance measure of new construction designs that are both structurally and materially efficient. This paper discusses the results of fire safety research on load-bearing sandwich wall assemblies and compares their integrity under exposure to fire to that of conventional stud walls.

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16 Smoldering Wave-Front Velocity in Fiberboard

Brenden, John J. and Erwin L. Schaffer

USDA For. Serv. Res. Pap. FPL 367, 1980

Reports on research to reduce or eliminate the tendency of fiberboard products to smolder. Efforts included examining available mathematical models that describe smoldering, plus developing a test method to evaluate the smoldering tendency of fiberboard.

17 Wood Products Used in Military Construction in the United States—1962 and 1978

Reid, William H. and David B. McKeever

USDA For. Serv. Resource Bull. FPL 8, 1980

Substantial quantities of lumber, poles and piling, plywood, particleboard, insulation board, and hardboard are used in constructing military facilities in the United States. A survey, as reported here, was made to estimate these quantities for 1962 and 1978 needed to build 13 types of facilities, each in three types of use.

18 Roofing Nail Performance in Structural Flakeboards

Schaffer, E. L., T. L. Wilkinson, and B. G. Heebink

Wood and Fiber 12(3):196-210, 1980

Maintaining the integrity of a shingle surface by minimizing nail popping is important to the acceptability of phenolic flakeboard for roof sheathing. This paper compares the movement of roofing nails driven into commercial and experimental phenolic flakeboards that had been exposed to a severe environment with nail movement in similarly exposed five-ply exterior grade Douglas-fir plywood.

19 Laminated Beams of Isotropic or Orthotropic Materials Subjected to Temperature Change

Cheng, Shun and T. Gerhardt

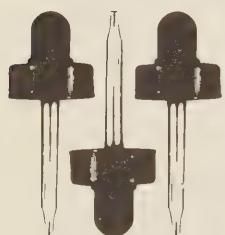
USDA For. Serv. Res. Pap. 375, 1980

This paper considers laminated beams with layers of different isotropic or orthotropic materials fastened together by thin adhesives. Calculated too are stresses that result from subjecting each component beam layer to different

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temperatures of moisture stimuli that may also vary along beam length. Stress intensity along bearing surfaces of beam layers is responsible for delamination failures of laminated structural elements.

Chemicals



20 Corrosion of Metal in Wood Products

Baker, A. J.

In: Durability of Building Materials and Components, American Society for Testing and Materials, STP 691, pp. 981-993, 1980

Presents new data on corrosion of 11 fastener materials in wood treated with waterborne salt preservatives. Slightly acid wood, when damp, causes metals to corrode; corrosion products from a metal fastener often cause slow deterioration of surrounding wood, as in house siding or boat docks. Fastener corrosion combined with wood deterioration reduces joint strength and weakens an assembly's structural integrity.

21 Tall Oil Precursors and Turpentine in Jack and Eastern White Pine

Conner, Anthony H., Marilyn A. Diehl, and John W. Rowe

Wood Science 12(4):194-200, 1980

Recent processes for upgrading crude tall oil prior to distillation and the fact that herbicides such as paraquat induce oleo-resin-soaked wood (lightwood) in treated pines suggested that the quantity and quality of tall oil and turpentine from northern pines could be increased. Results of this investigation together with similar data from paraquat-induced lightwood are presented in this paper.

22 Tall Oil Precursors in the Sapwood of Four Southern Pines

Zinkel, Duane F. and Daniel O. Foster

Tappi 63(5):137-139, 1980

This paper provides data on the diethyl ether extractives from four southern pines: slash, longleaf, shortleaf, and Virginia. The changes occurring in these extractives during kraft pulping are also detailed.

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23 Terpenoid and Other Extractives of Western White Pine Bark

Conner, Anthony H., Bhimsen A. Nagasampagi, and John W. Rowe

Phytochemistry 19:1121-1131, 1980

Detailed knowledge of the extractable constituents in bark is needed to assess potential for the millions of tons of waste bark from lumber and pulp production as an additional source of chemicals. A detailed chemical analysis of the benzene extract of western white pine bark showed fatty acids (6.5%), resin acids (9.5%), and neutrals (32%).

24 Prehydrolysis of Birch Wood with Sulfur Dioxide

Springer, Edward L. and Kimball A. Libkie

Tappi 63(7):119-120, 1980

The authors are studying prehydrolysis of hardwoods with sulfur dioxide at low water-to-wood ratios (about 1:1). The intended approach is to hydrolyze a large portion of the xylan hemicellulose prior to using the ignocellulosic residue for fiber products. This paper described work in progress on prehydrolysis of white birch.

25 Thermal Degradation of Kraft Lignin In Tetralin

Connors, W. J., L. N. Johanson, K. V. Sarkany and P. Winslow

Holzforschung 34:29-37, 1980

Lignin hydrocracking to provide phenolic feedstocks for chemical industries has recently generated renewed interest. This work was initiated (1) to provide detailed information on thermal processes involved in order to interpret the large variance in observed yields of low molecular weight phenols, and (2) to study the use of tetralin as a hydrogen donor in the cracking reactor instead of pressurized hydrogen.

26 Gel Chromatography and Association Complexes of Lignin

Connors, William J., Simo Sarkany, and Joseph L. McCarthy

Holzforschung 34:80-85, 1980

Chromatographic experiments in organic solvents for kraft and synthetic lignins and lignin isolated from wood degraded by brown-rot fungus have established that these lignins exhibit bimodal molecular size distribution. In experiments reported here, lithium chloride added to dimethyl-formimide changed the bimodal elution pattern to a single broad peak, indicating that lignin bimodality was due to molecular association.

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Degradation and Protection



27 Durability of Exterior Natural Wood Finishes in the Pacific Northwest

Feist, William C. and Edward A. Mraz

USDA For. Serv. Res. Pap. FPL 366, 1980

There is a growing demand for natural exterior wood finishes that retain the original attractive appearance of wood with the least color change and grain masking. Exposure results from an Olympia, Wash. study, started in 1966, indicate that natural finishes for wood can be used successfully for at least six years in climates where mildew growth is a problem.

28 Characteristics of Free Radicals in Wood

Hon, David N.-S., Geza Ifju, and William C. Feist

Wood and Fiber 12(2):121-130, 1980

Weathering changes of wood surface apparently result from UV-induced photooxidation of chemical components, of which lignin is the key light-absorbing component. Free radical intermediates thus play an important role in weathering. The primary aim of this work is to elucidate the formation and behavior of free radicals generated in wood surfaces upon exposure to UV light irradiation.

29 Fungi Associated with Decay in Treated Douglas-Fir Transmission Poles in the Northeastern United States

Zabel, Robert A., Frances F. Lombard and Allen M. Kenderes

Forest Products Journal 30(4):51-56

Objectives were (a) to isolate, identify, and determine relative frequency of principal decay and other wood-inhabiting fungi associated with decay development at the groundline zone of Douglas-fir poles; (b) to determine the frequency and extent of decay in poles versus time in service; (c) to determine effects of additional factors such as soil type and pole size.

30 Responses of Wood Decay Fungi to Polyoxin D, an Inhibitor of Chitin Synthesis

Johnson, Bruce R.

Material und Organismen 15(1):9-24, 1980

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Objectives for this initial study were (1) to determine if selected wood-decay fungi were sensitive to polyoxin D, one of a group of peptidyl pyrimidine antibiotics seeming to possess broadest anti-fungal activity, and (2) to establish whether chitin inhibition would prevent wood degradation by fungi. Sensitivity was measured by morphological aberrations produced and growth rate changes on nutrient agar.

31 Degradation of Cellulose by *Poria placenta* in the Presence of Compounds that Affect Hydrogen Peroxide

Highley, Terry L.

Material und Organismen 15(2):81-90, 1980

Certain brown-rot fungi may employ a non-protein system involving H_2O_2/Fe to break down cellulose in wood. In this study cellulose degradation by *Poria placenta* was observed in the presence of various materials that might affect H_2O_2 levels including oxidizing enzyme inhibitors, chelators, $\cdot OH$ and H_2O_2 quenching agents, protein-synthesizing inhibitors, thiol reagents, salts, phenolics and wood extracts.

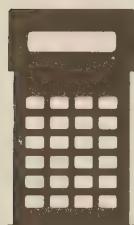
32 Comparison of Wood Preservatives in Stake Tests

Gjovik, L. R. and H. L. Davidson

USDA For. Serv. Res. Note FPL-02

Stake tests are useful for exploring the preservative properties of materials showing promise in the laboratory. This progress report describes the condition of modified-wood products and stakes treated with various preservatives and oils at the time of 1978 inspections. Similarly several previous progress reports have been published periodically since 1938 when the study began.

Design Data



33 Using Fracture Mechanics to Predict Failure In Notched Wood Beams

Murphy, Joseph F.

Proceedings First International Conference on Wood Fracture, Banff, Alberta, 1979. Linear-elastic fracture mechanics methodology was developed to

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analyze the stress field around cracks in metals, but the principles are also applied to wood. This paper shows how these principles can predict failure of notched beams in general and in specific cases such as beams with wide notches versus beams with narrow, slit-notches.

34 Effect of Substrate on the Fracture Toughness of Wood-Adhesive Bonds

White, Marshall S. and David W. Green

Wood Science 12(3):149-153, 1980

Wood use in composite materials stirred interest in applying fracture mechanics principles to wood-adhesive bonds. This study sought to determine how certain bulk and surface properties of wood materials affected fracture toughness of the bond between adhesive and wood surface, and whether fracture toughness is sensitive to induced changes in the zone between adhesive and wood surface.

35 Tapered Double Cantilever Beam Fracture Tests of Phenolic-Wood Adhesive Joints Part II. Effects of Surface Roughness, the Nature of Surface Roughness, and Surface Aging on Joint Fracture Energy

Ebewele, Robert O., Bryan H. River, and James A. Koutsky

Wood and Fiber 12(1):40-65, 1980

Although previous wood researchers have used fracture methods to evaluate the quality of bond, relatively few have attempted to use the double cantilever beam experiment that has been quite successful in determining metal bonding durability. This paper reports findings on the effects of surface aging and roughness and the nature of surface roughness on fracture energy of adhesive joints.

General



36 EVALUE: A computer Program Evaluating Investments in Forest Products Industries

Ince, Peter J. and Phillip Steele

USDA, For. Serv. Gen. Tech. Rep. FPL 30, 1980

EVALUE is a FORTRAN computer program for cash flow analysis of opportunities investment. It can be used to evaluate and analyze such

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investments as new manufacturing facilities or in economic studies of new technology. This paper is a user's guide to EVALUE and not an introduction to financial analysis. A user should be familiar with cash flow analysis techniques.

37 What Research Is Called For?

Youngs, R. L.

Proceedings Timber Supply: Issues and Options. Forest Products Research Society, Proc. No. P-79-24. p. 216-218, 1980

Strong economic and social pressures have produced, through legislation, a new framework for planning, developing, executing, and evaluating forestry programs, including research. The author discusses a national research program for forests and rangelands along with inventory and growth issues, and application of foundations, such as improved efficiency, for better forestry research decision-making.

38 Trends in Softwood Sawmill Overruns and Their Impact on Stumpage Prices

Spelter, Henry

Forest Products Journal 30(9):21-24, 1980

To estimate a log's sawmilling value, a necessary piece of information is its potential lumber yield. The difference between predicted and actual yield is called overrun. This paper identifies overrun determinants and examines the cumulative impact changes in these factors have had by comparing average overruns from studies and surveys conducted over the past two decades.

Processing

39 Programs for Computer Simulation of Hardwood Log Sawing

Adkins, W. K., D. B. Richards, D. W. Lewis, and E. H. Bulgrin

USDA For. Serv. Res. Pap. FPL 357, 1980

Four computer programs have been developed at the University of Kentucky as simulation models for investigating factors affecting sawn log value over four hardwood sawing methods: quadrant sawing, cant sawing, decision

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sawing, and live sawing with riper for grade. Information in this paper details the sawing methods, model assumptions, program organization, variables used, common storage areas, and program listings.

40 Does Gang Ripping Hold the Potential for Higher Clear Cutting Yields

Hallock, Hiram and Pamela Giese

USDA For. Serv. Res. Pap. FPL 369, 1980

This paper compares yields between gang ripping and traditional rough mill procedures using mathematical modeling and standard grade hardwood lumber graded by the National Hardwood Lumber Association. While gang ripping produces high total yields in all grades, the gain tends to be in the medium and shorter cutting lengths.

41 Effect of Cross Grain on Stress Waves in Lumber

Gerhards, C. C.

USDA For. Serv. Res. Pap. FPL 368, 1980

Stress waves offer potential advantages in lumber grading over mechanical stress raters, including faster throughput, lower induced fiber stress, and lower cost. As stress-wave stress grading systems are developed, an understanding of stress-wave interactions with lumber characteristics such as knots is desirable. This paper evaluates effect of cross grain (fiber or grain angle) on longitudinal compression stress waves in lumber.

42 Lumber Values from Computerized Simulation of Hardwood Log Sawing

Richards, D. B., W. K. Adkins, H. Hallock, and E. H. Bulgrin

USDA For. Serv. Res. Pap. FPL 356, 1980

Most U.S. hardwood sawyers turn a log on the carriage several times to get the highest grade lumber. This study used simulated logs with hidden knots, turned the log on the carriage, and made other improvements to determine how much in value live sawing or live ripping the four centrally located wide boards by a mathematical formula would surpass 4-sided "sawing for grade."

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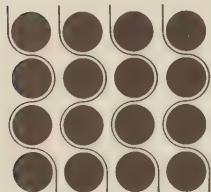
43 Use of Acoustic Emissions to Identify High Levels of Stress During Oak Lumber Drying

Skaar, Christen, William T. Simpson, and Robert M. Honeycutt

Forest Products Journal 30(2):21-22, 1980

The tendency for hardwood lumber to develop surface and end checks limits the rate at which it is dried. Check formation is often accompanied by acoustic emissions, short bursts of energy that may or may not be audible. This study explores the feasibility of improving control of the drying process by using an electronic "stethoscope" to detect check formation.

Pulp and Paper



44 Chemical Additives to Pulps: Effect on Drainage and Strength of Papers Containing Oak Pulps

Klungness, J. H. and M. P. Exner

Tappi 63(6):73-76

As softwood pulps become less available, hardwood—especially oaks—must be utilized more. Yet because of the morphological characteristics of pulps from hardwood, their use for linerboard, for instance, is limited. This study was undertaken to determine how effective chemical additives can be in improving drainage characteristics and strength of papers containing oak kraft pulp.

45 Quinones in Alkaline Pulping: Characterization of an Anthrahydroquinone—Quinone Methide Intermediate

Landucci, Lawrence L.

Tappi 63(7):95-99

A recently completed kinetic study of the veratryl analog of the lignin model guaiacylglycol- β -guaiacyl ether showed that anthrahydroquinone had no effect on the alkaline cleavage of blocked phenolic β -ether units. The present investigation characterizes the reduced form of anthraquinone responsible for accelerated delignification and its reaction with quinone methides.

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46 **Effect of Quinones and Amines on the Cleavage Rate of β -O-4 Ethers in Lignin During Alkaline Pulping**

Obst, J. R. and Necmi Sanyer

Tappi 63(7):111-114, 1980

To further understand delignification behavior in the presence of various additives, the present study determines the effects of anthrahydroquinone and of primary amines on the rate and extent of β -ether cleavage of lignin model compounds with both free (guaiacyl) and blocked (veratryl) phenolic units.

Residues and Energy



47 **Extending Wood and Energy Supply Through Forest Products Research**

Youngs, Robert L.

Presented at International Union of Forestry Research Organizations Conference of Div. 5, Oxford, England, April 1980

The wood scientist is being tested today especially because of three factors: wood is a leading industrial and engineering material; timber supply is increasing, but often not in the sizes, species, and locations most wanted by timber processors; and a strong demand for timber continues and is projected to increase. This paper describes some utilization options that are emerging.

48 **The Economics of Wood Fuel Use**

Skog, Kenneth E.

From: Proceedings Mid-American Wood Combustion Conf., November 1979

This paper presents a method to determine how a wood-fueled system compares, economically, to alternative systems. It further illustrates its use to calculate the highest price that can be paid for wood fuel given an alternative system, before the alternative system would be cheaper.

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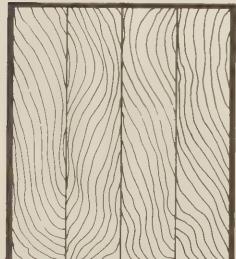
49 Examining the Midwest's Wood Fuel Resource

Stone, Robert N.

From: Proceedings Mid-American Wood Combustion Conf., November 1979

This paper considers the Midwest's timber resource situation in four segments: stock of wood and bark in the forest, annual growth of timber not used for nontimber purposes, wood wasted in timber harvesting operations, and wood residue from manufacturing. The author presents factors to convert conventional forest resource inventory statistics into wood tonnage estimates and explores economic supply and availability.

Wood Materials



50 Structural Composite Panels: Market Outlook for the 1980s

Dickerhoof, Edward, Thomas C. Marcin, and Charles G. Carll

Plywood and Panel 20(11):21-22, 1980

Describes an optimistic outlook for structural composite panels for the 1980's detailing important market factors, such as new residential housing demands and the increasing number of women in the labor force. Structural board developments are also outlined.

51 Structural Flakeboard from Short-Rotation, Intensively Cultured Hybrid Populus Clones

Geimer, Robert L. and John B. Crist

Forest Products Journal 30(6):42-48, 1980

The USDA Forest Service Maximum Yield program has combined the expertise of specialists to determine improved methods for growing fibers from woody plants. The purpose of this study was to determine if short rotation intensively cultured poplars would be suitable as raw material for structural flakeboard, and to relate board performance to characteristics of the raw materials.

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52 Data Basic to the Engineering Design of Reconstituted Flakeboard

Geimer, Robert L.

Proceedings 1979 Washington State University Symposium on Particleboard,
pp. 105-125, 1980

The design of flakeboards for applications with specific flex properties requires a knowledge of the relationship between density, strength, and stiffness. This research establishes the relationship between specific gravity (density) and the physical and mechanical properties of reconstituted wood flakes. The scope includes the evaluation of several flake types, two species, and several degrees of flake alignments.

53 Determining Optimum Thickness-to-Weight Ratio for Structural Flakeboard Panels

Lehmann, William F. and E. L. Schaffer

Proceedings 1979 Washington State University Symposium on Particleboard
pp. 127-140, 1980

Evaluations of 1/2-inch-thick structural flakeboards suggest these panels would perform adequately as structural roof or wall sheathing but that thicker panels might be desirable for floor sheathing. In this research experimental panels of similar basis weights at various thicknesses and densities were manufactured; resultant physical and dimensional properties were compared and related to needs of various sheathing types.

54 Wood Products Used in Constructing Conservation and Development Projects by the Corps of Engineers in the United States—1962 and 1978

Reid, William H. and David B. McKeever

USDA For. Serv. Resource Bull. FPL 9, 1980

This report presents estimates of the amounts of lumber, laminated lumber, poles and piling, and plywood used in constructing civil conservation and development projects by the Corps of Engineers in the United States during 1962 and 1978. The consumption of these materials is shown for five categories of nonmilitary construction and three types of use.

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Cooperative Research

Listed below are recent publications from universities or individuals involved in cooperative research with the Forest Products Laboratory. Copies are not available from the Laboratory, but may be obtained from the contacts listed following each publication.

Effect of Selected Clear Finishes on the Vaporization of Pentachlorophenol from Treated Wood

Ingram, L. L., G. D. McGinnis, and W. C. Feist

Mississippi Forest Products, Utilization Laboratory, Drawer FP, Mississippi State, MS 39762

The Chemistry of Lignin Degradation by White-Rot Fungi

Chang, H.-m., C.-L. Chen, and T. K. Kirk

In: Lignin Biodegradation: Microbiology, Chemistry and Potential Applications

CRC Press, Boca Raton, FL 33432

Effects of Lathe-Check Orientation and Conditioning Time on Gluability of Douglas-Fir Veneer

Sandoe, M. D., and J. D. Wellons

Forest Products Department, Oregon State University, Corvallis, OR 97331

End Joint Tensile Strength of 3/4-Inch Douglas-fir Laminated Veneer Lumber (LVL)

Sampson, Dennis

Master of Science Thesis

University of Washington, Seattle, WA 98125

Use of Acoustic Emissions to Identify High Levels of Stress During Oak Drying

Skaar, C., W. T. Simpson, and R. Honeycutt

Forest Products Journal 30(2):21-22

Forest Products Research Society, 2801 Marshall Court, Madison, WI 53705

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Device for Rapid Determination of Wood Sample Volume by Immersion

Gorvad, Michael R., and Kevin B. Strauss
Wood Science 13(2):75-76

Forest Products Research Society, 2801 Marshall Court, Madison, WI 53705

Natural Variations of Wood Properties

Proceedings of IUFRO Working Party S.5.01-02 held at the All Division 5 Conference in Oxford, UK.

Kommissionsverlag, Buchhandlung Max Wiedebusch, Dammtorstr. 20, 2000 Hamburg 36

Mycorrhizal Development on Red Pine in Nursery Beds Treated With an Herbicide

Palmer, J. G. Sr., J. E. Kuntz, J. G. Palmer, Jr., and R. F. Camp

Department of Forestry, University of Wisconsin, Madison, WI 53705

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Ordering Publications— Change of Address

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